Game-Based CBT with Artificial Intelligence: A Method for Correcting Cognitive Distortions by Revisiting the Past

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Abstract

Given that the most used therapies in psychiatry, Cognitive Behavioral Therapy (CBT) and Mindfulness-Based Cognitive Therapy (MBCT), were developed to treat depression, a new approach is needed for disorders such as Internet Gaming Disorder and Gambling Disorder, where the issue lies not in negative emotions themselves but in their expression through problematic behaviors. These behaviors act as the patient's form of "self-prescription" to relieve stress, making it essential to propose alternative coping strategies that can effectively alleviate negative emotions. This paper proposes a novel game-based digital therapy method that reflects each patient's individual "automatic thoughts," based on an emotional theory expanded into a four-dimensional cognitive concept that incorporates both the feedback from coping strategies and the subjective interpretation of that feedback. An LLM agent based on a large language model and a doctor agent based on rule-based machine learning work complementarily, enabling the patient to safely and repeatedly practice active coping strategies in crisis situations.

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Viewpoint

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Abstract

Given that the most used therapies in psychiatry, Cognitive Behavioral Therapy (CBT) and Mindfulness-Based Cognitive Therapy (MBCT), were developed to treat depression, a new approach is needed for disorders such as Internet Gaming Disorder and Gambling Disorder, where the issue lies not in negative emotions themselves but in their expression through problematic behaviors. These behaviors act as the patient's form of "self-prescription" to relieve stress, making it essential to propose alternative coping strategies that can effectively alleviate negative emotions. This paper proposes a novel game-based digital therapy method that reflects each patient's individual "automatic thoughts," based on an emotional theory expanded into a four-dimensional cognitive concept that incorporates both the feedback from coping strategies and the subjective interpretation of that feedback. An LLM agent based on a large language model and a doctor agent based on rule-based machine learning work complementarily, enabling the patient to safely and repeatedly practice active coping strategies in crisis situations.

Keywords: Mental health; Cognitive Behavior Therapy; Psychosocial Intervention; Game; Artificial intelligence; Large language Model

Introduction

Large language models (LLMs) are demonstrating possibilities that were previously not attempted in traditional medical services. It is no longer surprising that LLMs, led by ChatGPT, achieve high scores above 90% on the U.S. Medical Licensing Examination (USMLE).[1,2] Instead, the latest research trends focus on maximizing users' potential and applying AI to specialized fields. OpenAI's newly announced "ChatGPT with Canvas" did not showcase groundbreaking technology, but it did demonstrate the role of AI as a "collaborator," communicating naturally with users when writing and coding.[3] Smartphone manufacturers are contemplating ways to make AI functions, which "we all know," accessible even to those unfamiliar with technology.[4] Medicine has long been one of the most anticipated fields for AI research, but ironically, it is also one of the slowest to adopt it. This is because incomplete and inscrutable technologies can violate one of medicine's most fundamental principles: "Do no harm." Therefore, there is a wealth of research being published on improving the accuracy of medical Question-Answering tasks and explaining the reasoning process. However, investing significant time and resources to increase the accuracy of AI from 90% to 91% in solving the USMLE may be inefficient and impractical. Since the data provided to AI is not in a perfect state that includes all necessary information, hallucination and misalignment are inevitable. At this point, rather than striving for a mere 1% improvement in accuracy, it is essential to reflect deeply on the direction of progress. This paper discusses the therapeutic potential and direction of AI, which has

been scarcely discussed until now. In particular, it addresses the characteristics of diseases where traditional therapeutic techniques, such as cognitive behavioral therapy (CBT) and mindfulness-based cognitive therapy (MBCT), show limitations, and introduces a new perspective on treatment techniques that can be applied to such diseases.

Background

Cognitive Behavioral Therapy and Mindfulness

Cognitive Behavioral Therapy (CBT) is a therapeutic method focused on addressing current problems by teaching techniques to modify dysfunctional thoughts and behaviors.[5] Patients suffering from depression tend to apply past events associated with depressive emotions to their present problems. The cycle of thought shown in Figure 1 is gradually reinforced depending on the severity of the disease, and this is referred to as “automatic thoughts.” The Interacting Cognitive Subsystems (ICS) is a comprehensive, systematic model that explains the organization and function of the cognitive resources underlying human cognition.[6]

The goal of CBT is to modify “automatic thoughts” through dysfunctional thinking. The manual for CBT, developed by Aaron Beck for the treatment of depression, is considered a primary approach for a wide range of mental disorders such as generalized anxiety disorder, insomnia, and ADHD.

Meanwhile, mindfulness originates from Buddhist meditation techniques and emphasizes accepting thoughts without rejection.[7] Patients acknowledge and accept their current thoughts while seeking stability through meditation-focused breathing. In Cognitive Behavioral Therapy (CBT), erroneous beliefs are corrected, whereas mindfulness takes a significantly different approach by adopting a more passive stance, focusing on accepting thoughts rather than correcting them. Mindfulness-Based Cognitive Therapy (MBCT) was developed to prevent depression relapse, based on Aaron T. Beck’s CBT and Jon Kabat-Zinn’s Mindfulness-Based Stress Reduction (MBSR). It was introduced as an 8-week group therapy in 2002 by Zindel Segal from the University of Toronto, Mark Williams from the University of Oxford, and John Teasdale from the University of Cambridge.[8] MBCT was initially designed to treat recurrent depression[9-11], but research has extended its use to anxiety disorders[12-14], insomnia[15,16], bipolar disorder[17], panic disorder[18], chronic pain[19], cancer-related pain[20], and stress[21]. Patients who undergo MBCT rate it significantly higher in self-assessment, and it improves the subscales of “concerning danger” and “controllability of thoughts”[22].

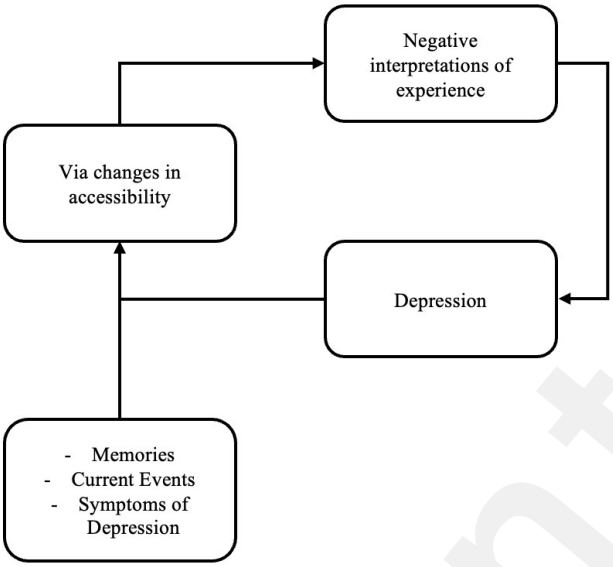

Figure 1. Interacting Cognitive Subsystem[6]

Nevertheless, so far, studies have shown no statistically significant difference between MBCT and CBT.[22-24] MBCT has demonstrated distinct effects in patients who have experienced three or more recurrences of depression compared to CBT[25], but these effects are also limited to the short term[22]. Although studies like Interacting Cognitive Subsystems (ICS) have explored the theoretical mechanisms of MBCT[6,26,27], further detailed research is still needed.[28]

A New Perspective on Mental Disorders

While mood disorders such as depression and anxiety disorders focus on emotions like sadness and anxiety as the core problem, disorders characterized by external behaviors—such as Internet Gaming Disorder, Oppositional Defiant Disorder, and Gambling Disorder—may involve underlying causes for these problematic behaviors.[29-32]

Patients with Internet Gaming Disorder, often encountered in clinical settings, frequently report that they began gaming due to interpersonal difficulties, academic underachievement, or past trauma.[33-35] Interviews with hospital patients indicate that gaming is often initiated as a way to alleviate negative emotions. However, some patients also continue gaming due to the addictive nature of the game itself, regardless of its initial stress-relieving purpose. An internal investigation by the research team yielded results similar to previous studies that classified Internet Gaming Disorder patients into five distinct groups based on their characteristics.[36]

Similarly, interviews with patients admitted for substance use disorder often reveal that they started using drugs due to the influence of people around them during childhood. This aligns with existing studies identifying environmental factors that make substances easily accessible as risk factors for substance use disorder.[37]

A common characteristic of disorders such as Internet Gaming Disorder and substance use disorder is that patients receive a form of reward from their behavior by alleviating negative emotions through it.[1,38] From this perspective, the maladaptive behavioral patterns exhibited by patients can be understood as a form of “self-prescription”—an attempt to manage or relieve negative emotions through their own chosen methods.[39]

Limitations of Traditional Treatment Methods

CBT (Cognitive Behavioral Therapy) and MBCT (Mindfulness-Based Cognitive Therapy) have shown limitations in treating disorders such as Internet Gaming Disorder, Gambling Disorder.[40-42] Considering that CBT and MBCT were originally developed for treating depression, addressing disorders characterized by problematic behavior requires therapeutic principles distinct from traditional approaches.

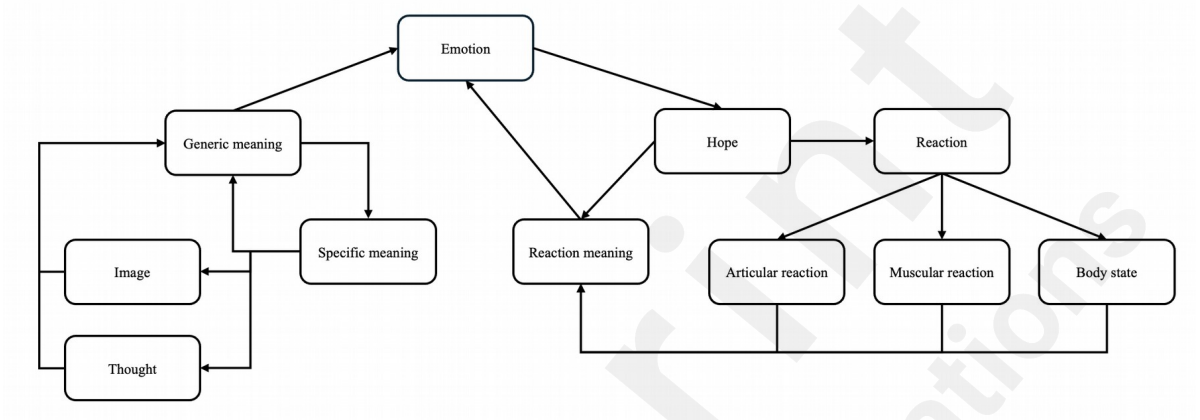

Figure 2. Modified Interacting Cognitive Subsystem[28]

Figure 2 presents the outcome of the research team's previous study, which expands upon the Interacting Cognitive Subsystems (ICS) model. As previously mentioned, emotions are not only the result of subjective interpretations of situations but also a four-dimensional concept that includes feedback from coping strategies and subjective interpretations of that feedback. In other words, depressive emotions should be understood as continuous time units, starting with the initial feeling of sadness and extending to the positive reward effect from the patient's use of maladaptive self-prescription strategies to relieve negative emotions.[28]

For example, a student with a fear of public speaking may not experience anxiety only during the presentation itself. Even after the presentation, the student might ruminate on their performance and feel guilt or self-criticism, thereby perpetuating the anxiety. However, if the student evaluates their performance and feels they delivered the presentation better than expected, despite initial nervousness, the positive assessment could generate confidence in future presentations, overriding the initial negative emotions. This illustrates that personal evaluation of coping strategies can have a greater impact on experience and emotion than the triggering event itself. This hypothesis aligns with the process of learning the relationship between the hedonic response during reward consumption and the motivated behavior of pursuing rewards.[38]

Although CBT touches on the concept of a "reward effect" from patient behavior, its explanation and application in treatment protocols are limited. To overcome the therapeutic limitations of CBT and MBCT, treatment must not only identify the patient's automatic thoughts but also offer new coping strategies to address maladaptive self-prescription behaviors. This is especially important for patients with Internet Gaming Disorder or Gambling Disorder, as they often exhibit characteristics of psychological immaturity, making the presentation of alternative strategies even more crucial.

Previous Research

EndeavorRx is a video game approved by the FDA for children with ADHD. In the STARS-ADHD clinical trial, the experimental group treated with the video game showed significant improvement in TOVA-API, a key ADHD measurement index, compared to the control group, with no severe side effects reported.[43]

Game-based digital therapeutics grounded in CBT theory remain a largely unexplored field. In a study conducted within a virtual reality (VR) environment to explore the gaming motivations of patients with Internet Gaming Disorder, researchers applied the principles of CBT to encourage self-reflection on problematic behaviors.[44] Similarly, NICO-Thera is a digital therapeutic that recreates craving-inducing situations for smokers in a VR environment, teaching them coping strategies through guided choice-based responses.[45] Programs using augmented reality (AR) technology have also proven effective in memory training for elderly individuals.[46] Additionally, a game-based application targeting college students with perfectionist tendencies provided an affordable alternative to traditional CBT interventions.[47]

Interestingly, meta-analysis results revealed that, contrary to expectations, the greatest effectiveness was observed among older adults, while adolescents showed the least improvement.[48] One potential explanation is that if the quality of a game is low, younger generations, who are more familiar with digital devices, may find it “boring or childish,” resulting in a negative impact.[49] From this perspective, the current game-based digital therapeutics have clear limitations, as they follow predefined rules and solutions. Given the need for game-based therapies to provide engaging new experiences with a high quality, it is essential to apply AI technology to achieve a variety of outcomes. At the same time, methods must be developed to control AI to ensure it functions effectively as a medical device.

Methods

Game Based Digital Treatment

When stress is alleviated through a coping strategy chosen in a crisis, that behavior becomes reinforced, much like natural selection, as it is linked to past experiences.[50-52] In fact, this is a universally known principle that in times of crisis, we rely on strategies that have successfully resolved past issues. While traditional treatment strategies emphasize “automatic thoughts” that are passively reinforced by external environments, the Game-Based Digital Treatment discussed in this paper simultaneously highlights the “reward effect” resulting from the patient’s active behavior.

Games are sometimes negatively associated with addiction. However, the key distinction between games and other multimedia lies in the fact that the user actively chooses their actions in an environment they cannot experience in reality. The core value of games is that they provide patients suffering from mental illness the opportunity to attempt alternative coping strategies in crisis situations, offering the possibility to view situations from different angles with relatively low cognitive load. Traditional therapeutic methods, which mainly attempt cognitive restructuring through counseling and drawing, present obstacles for patients with underdeveloped cognitive abilities.[53,54]

Implementing CBT and MBCT through games offers various advantages. First, adolescents and

young children, who are in the middle stage of cognitive development, experience lower cognitive load during the treatment process. Through sensory feedback such as visual and auditory cues, games can realistically simulate patients' automatic thoughts. Secondly, it may have a positive effect on improving treatment adherence. Psychiatric medications and psychological counseling often suffer from poor adherence due to side effects and the difficulties of outpatient care.[55-57] Recent studies have explored the relationship between the reward effect provided by games and patients' adherence to treatment.[58] Thirdly, with the widespread use of smartphones, people have become accustomed to digital environments, and a significant portion of those suffering from Internet Gaming Disorder, Gambling Disorder, and Substance Use Disorder—who are primarily children and adolescents—are already familiar with new media. Lastly, game platforms, which encourage more active behavior, allow patients to feel a sense of agency in their treatment and provide greater motivation to participate in the therapeutic process actively.

Although research on digital treatments using games has gained attention recently, most studies selectively apply only parts of CBT. This is due to the difficulty in converting systematically designed protocols, which heavily rely on the expertise of psychological counselors, into software. Programs that analyze patients independently are challenging to evaluate for safety and consistency in clinical trials. To overcome the reality that promising new technologies like LLMs are difficult to apply, this paper presents a new perspective on how unstable technologies like AI can be adapted for medical purposes.

Small-Scenario

Stanford Smallville is a study that demonstrates the possibility of characters using LLMs (Large Language Models) to form relationships and influence each other.[59] In this virtual town, characters implement plans and actions through processes of memory, perception, and recall. The series of processes presented in this study resembles the relationship between emotions and actions defined in Figure 2. The Figure 3 depicts the structure of an agent based on Modified Interacting Cognitive Subsystems.

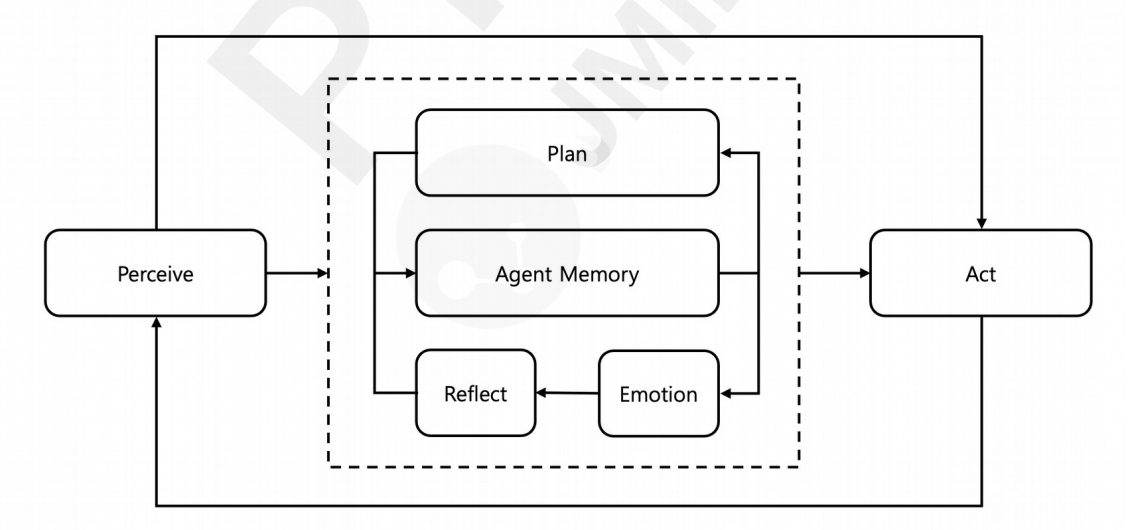

Figure 3. Structure of LLM agent

The most notable feature of Stanford Smallville is that the agents modify their plans and actions

based on their interactions with each other. This advantage can be applied to the principles of CBT (Cognitive Behavioral Therapy), where faulty beliefs are corrected by allowing patients to reconsider their automatic thoughts from a different perspective.

In the technique proposed by this paper, the patient first works with a psychological counselor to explore the specific situations that trigger negative emotions. The counseling session covers people, places, objects, and past memory related to feelings of depression or anxiety. Next, using the data on the people, places, and utterances mentioned during the first session, along with LLMs, the situation triggering the negative emotions is recreated in a virtual environment called “Small-Scenario.” The characters and environments in the game reflect the subjective people and places from the patient’s memory.

During the game therapy stage, the patient freely controls a character that represents themselves over a game period of 1–2 days, interacting with other characters. The primary goal of this process is for the patient to express emotions such as anger, depression, and sadness toward the source of their stress while simultaneously accepting those emotions. The goal of the program is to demonstrate, through repeated gameplay, that the patient’s active thoughts and behavioral changes can influence the surrounding characters and environment, leading to different outcomes than before. This allows the patient to discover their automatic thoughts and learn positive coping strategies for handling situations.

Doctor Agent

In Small-Scenario, the agents are broadly classified into the patient, characters, and the doctor. The characters are further divided into hostile characters, positive characters, and bystanders. Among these, the “doctor” is a very special agent that plays a key role in setting the overall direction of the game. The doctor agent performs three main roles: first, it assists by exploring faulty beliefs together with the patient through conversation. Second, it serves as a guide in stressful situations, helping the patient choose alternative coping strategies. Lastly, it controls the actions and speech of other agents to ensure they remain appropriate and therapeutic within the overall scenario.

While agents powered by LLMs have the strong advantage of behaving freely like real people, they also have limitations that make them difficult to use as medical devices due to hallucinations. The doctor agent in Small-Scenario is trained with rule-based machine learning, which forces the LLM-trained agents to act according to the direction of the scenario. In other words, when the patient’s speech is analyzed and it is determined that they are executing alternative coping strategies well, other agents are commanded to engage in speech or actions that produce positive outcomes. Rule-based machine learning ensures predictable results, allowing the program to function as a medical device, while LLMs can overcome the limitations of traditional medical devices by creating a virtual environment that aligns with the user’s thoughts. Within this structure, the hallucination drawback of LLMs can be mitigated by considering different pathways, particularly when dealing with unpredictable human relationships. The doctor agent repeatedly asks the patient “questions” throughout the scenario. For example, when the doctor agent detects that the patient is experiencing conflict with a character, it doesn’t make arbitrary judgments but instead confirms this through natural questions. Based on the data collected from the patient’s responses, the doctor agent adjusts the direction of the scenario and influences the behavior of other agents. Therefore, rather than relying solely on the accuracy of the LLM, this approach satisfies the stability required for a medical device by working as a strategy centered on natural questions in Human-AI interaction. Figure 4 provides an overview of the entire framework.

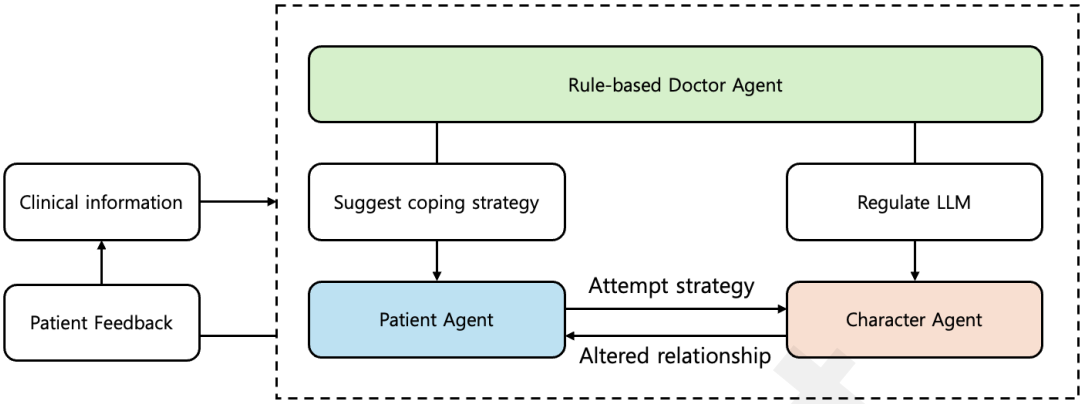

Figure 4. Schematic diagram of Small Scenario

The patient provides feedback on how natural the characters and environment felt at the end of the scenario.

Discussion

Digital therapy that leverages the characteristics of artificial intelligence (AI) and games remains an unexplored and undeveloped field. Each of these elements initially seemed difficult to apply in hospital settings. However, just as medication can become toxic when overused, the key lies in how these technologies are applied. Small-Scenario has the potential to be most effective when used as a supplementary tool alongside conventional hospital treatments. Beyond merely enhancing treatment adherence through the enjoyment provided by games, it offers a deeper opportunity for patients to understand their conditions. For example, after each scenario concludes, patients evaluate how well the character agents reflect reality. The feedback such as “There is an important relationship that had not been said before.” can provide doctors with new insights about the patient that were previously unknown. Furthermore, by applying psychological theory-based agent structures to the patient agent, the system can analyze emotions and behaviors based on the patient’s interactions within the virtual environment.

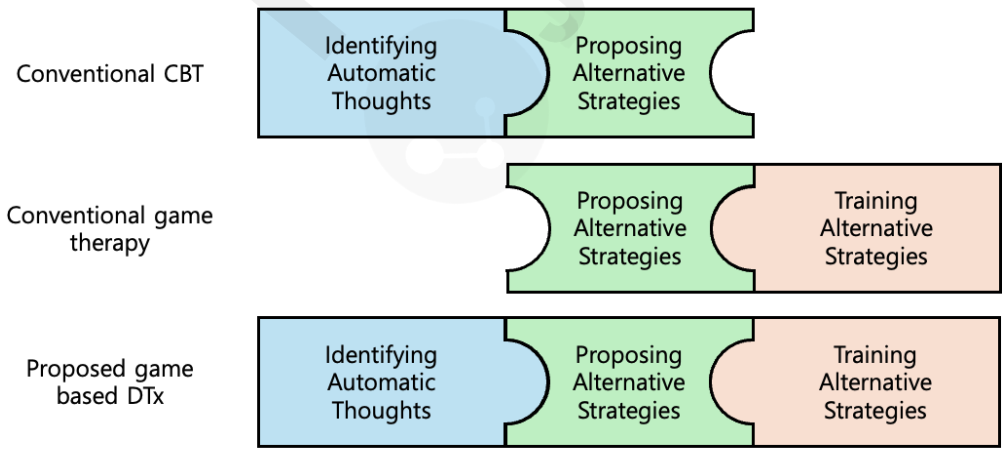

Figure 5. Comparison Between Small-Scenario and conventional treatment

Figure 5 presents a comparison between the proposed method and traditional therapeutic approaches.

Conventional CBT involves the therapist identifying automatic thoughts through counseling and providing coping strategies verbally, but there are limitations in training and practicing these strategies. While current game-based digital therapies allow patients to actively train in conflict situations, they do not adjust the training methods according to individual characteristics and automatic thoughts. The game-based digital therapy proposed in this paper takes these strengths and weaknesses into account and is designed to deliver personalized programs that consider each patient's automatic thoughts safely and effectively.

A major concern when applying the Small-Scenario framework is the need for original patient data to create the game, which could lead to significant harm in the event of a data breach. Therefore, research on security policies—such as data anonymization, lightweight deployment on hospital computers, and data collection and disposal policies—must be conducted from the early stages of development. Ensuring that AI models produce consistent and controllable results is also essential. Training LLM agents through prompts and fine-tuning helps the system better understand the patient and provide consistent responses.[1,2] However, LLM-based models alone cannot fully overcome issues such as hallucinations, necessitating the use of additional technologies. This paper proposes using a rule-based machine learning-trained doctor agent to create a framework that allows for quantitative evaluation during clinical trials. Further research is required to determine the optimal level of control over LLMs to prevent side effects during treatment.

Despite these safeguards, applying new technologies in medical contexts remains a significant challenge. Uncontrolled LLM responses, especially those overlooked during development, could negatively impact patients with mental health disorders. Nevertheless, as the gradual application of LLMs in the medical field seems inevitable, discussing how these technologies can be applied should take precedence over merely improving model performance.

The method proposed in this paper offers a compelling structure, akin to a patient and therapist working together in a "time loop" to try and change the past. While the framework presented here may not fully represent all game-based digital therapies, it serves as a foundation for exploring new perspectives on the integration of AI and games in therapy. Follow-up studies are needed to determine whether this proposed framework can function effectively and eventually replace traditional therapeutic methods. Although the framework may not yet represent the standard for game-based digital therapy, it lays the groundwork for a new way of thinking about the role of AI and games in healthcare.

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Conflicts of Interest

none declared

Abbreviations

JMIR: Journal of Medical Internet Research
CBT: Cognitive-behavioral therapy

ICS: Interacting Cognitive Subsystems
MBCT: Mindfulness-Based Cognitive Therapy
MBSR: Mindfulness-Based Stress Reduction
ADHD: Attention-Deficit Hyperactivity Disorder
TOVA: Test of Variables of Attention
API: Attention Performance Index
LLMs: Large Language Models
AI: Artificial Intelligence
USMLE: U.S. Medical Licensing Examination
VR: Virtual Reality
AR: Augmented Reality

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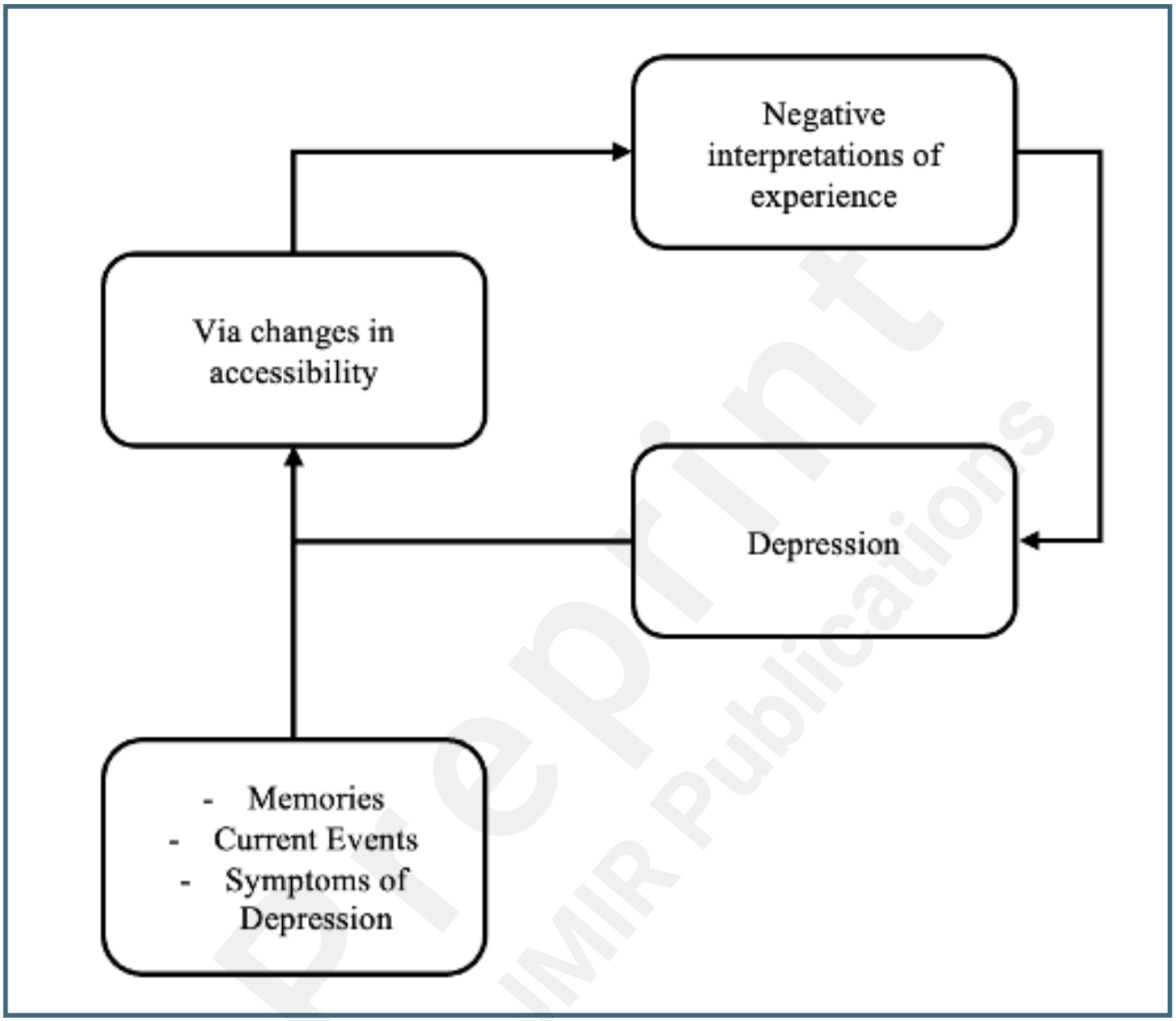
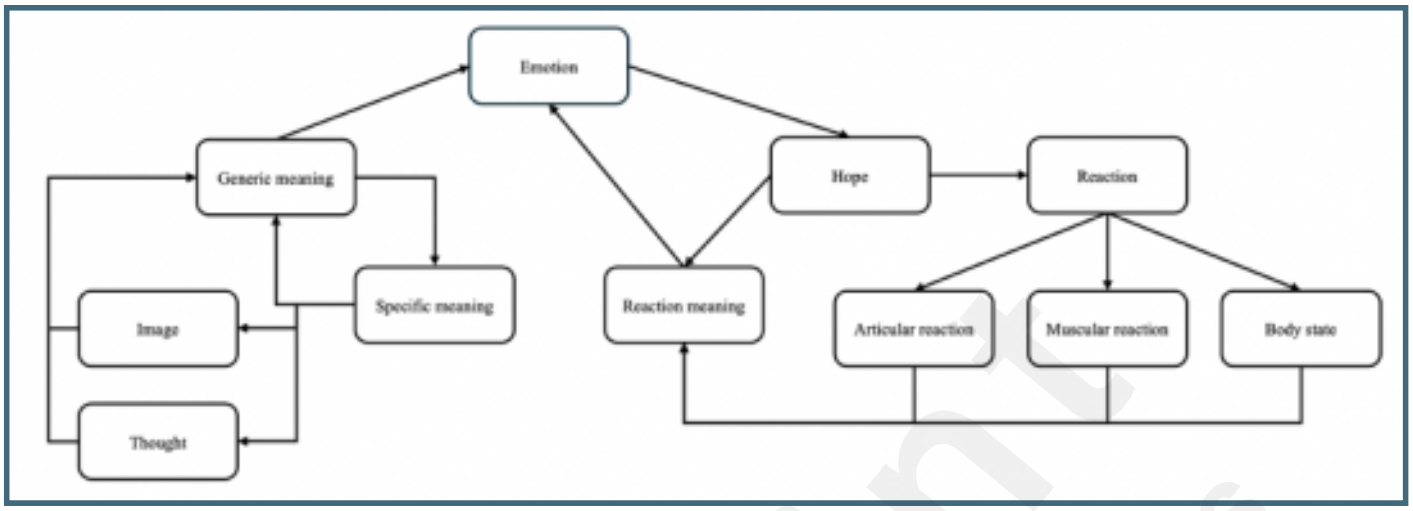
Supplementary Files

Figures

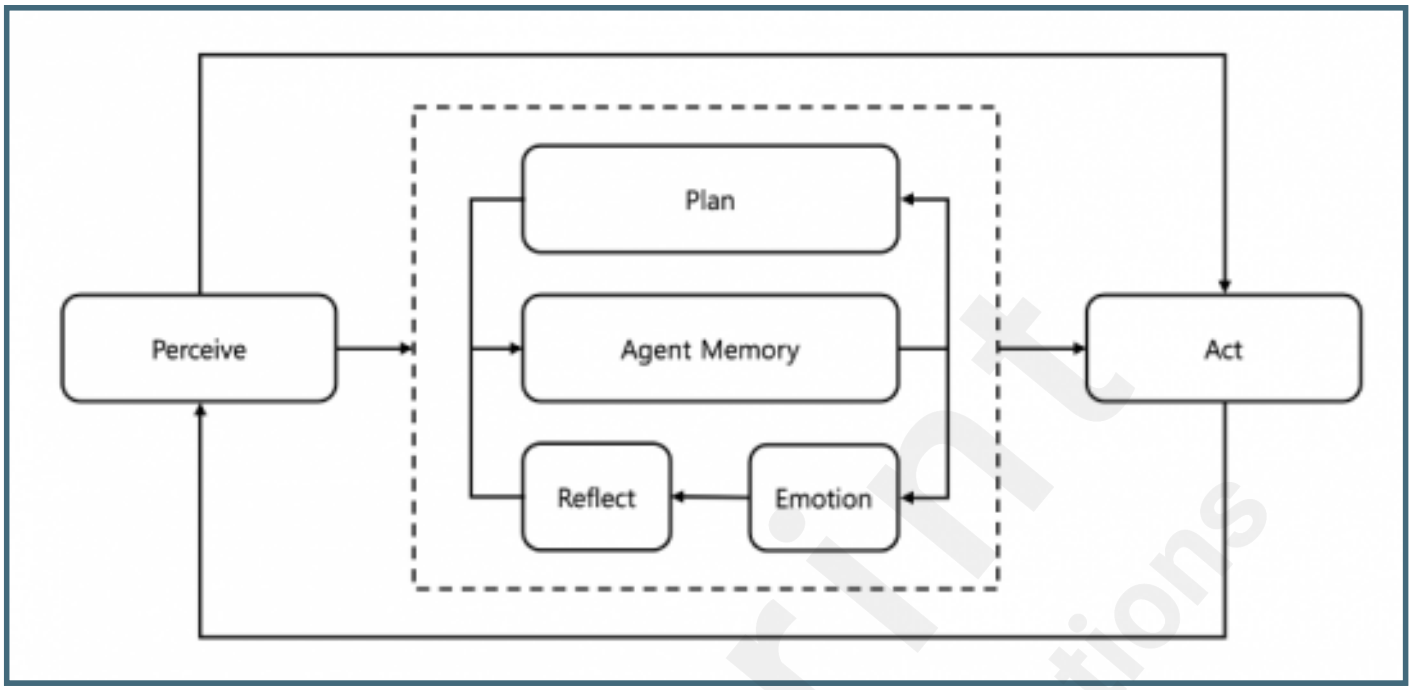
Interacting Cognitive Subsystem.



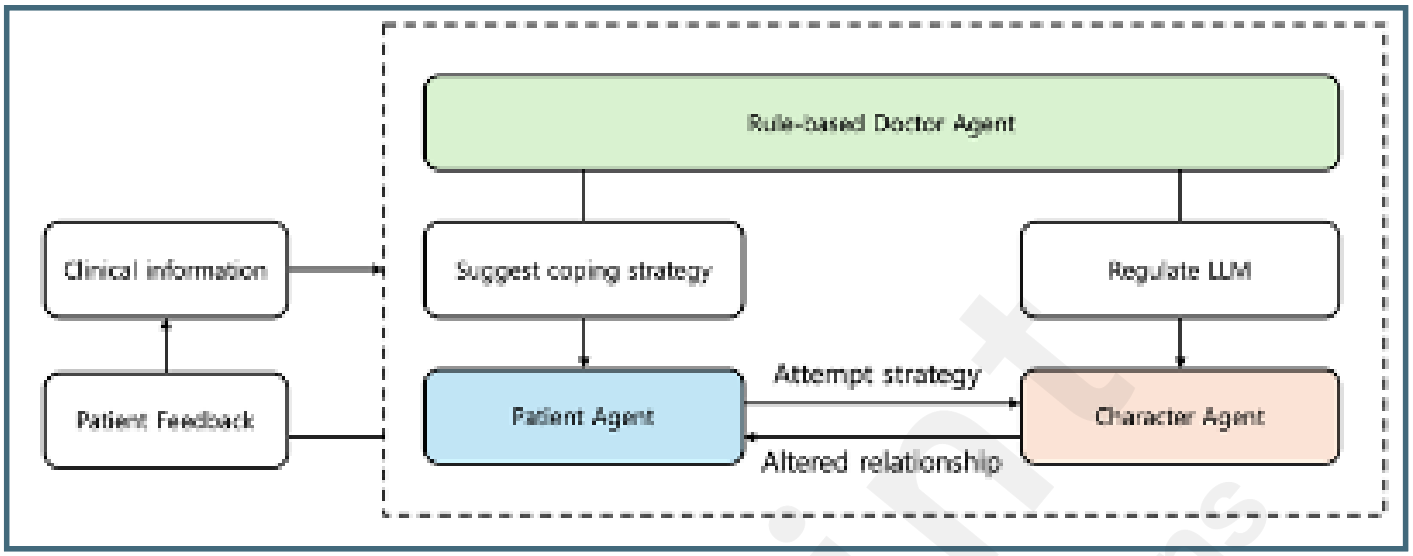
Modified Interacting Cognitive Subsystem.



Structure of LLM agent.



Schematic diagram of Small Scenario.



Comparison Between Small-Scenario and conventional treatment.